Optimization of number and location of solar plants and storage in a power grid with high penetration of renewables

Benjamín A. Carreras[1,2], Pere Colet[1], José M. Reynolds-Barredo[2], and Damià Gomila[1]
[1]Instituto de Física Interdisciplinar y Sistemas Complejos, IFISC (CSIC-UIB)
Campus Universitat de les Illes Balears, E-07122 Palma de Mallorca, Spain.
[2]Departamento de Física, Universidad Carlos III de Madrid, 28911 Leganés, Madrid, Spain.

We analyze the risk of blackouts with high penetration of variable renewable energy sources (VRESs) using a model for the long-term evolution of the power grid including propagation of cascading failures, day-to-day fluctuations of renewable generation and moderate use of storage [1]. As a case study, we consider the replacement of conventional power plants by solar photovoltaic generation combined with storage in the power grid of the Balearic Islands. We analyze grid resilience and stress as VRESs are progressively incorporated and evaluate the VRES performance as the average fraction of daily demand covered by renewables. We find that VRES intrinsic variability typically increases the grid stress and the blackout risk. However, if VRESs are implemented in a distributed way, the spatial spreading of the generation may have a positive effect on grid resilience. Futhermore we propose a method to find the optimal number and location of solar plants while minimizing the amount of storage needed to keep the risk and performance at levels comparable to a power grid with only conventional plants [2].

---

[1] B.A. Carreras, P. Colet, J.M. Reynolds-Barredo, and D. Gomila, *Assessing blackout risk with high penetration of variable renewable energies*, IEEE Access **9**, 132663 (2021).

[2] B.A. Carreras, P. Colet, J.M. Reynolds-Barredo, and D. Gomila, *Optimization of number and location of solar plants and storate in a power grid with high penetation of renewables*, submitted for publication.